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South Fork Wind (SFW) Responses to EPA comments on the August 2020 Draft Air Quality Modeling Protocol for Operations and Maintenance Emissions for the South Fork Wind Farm (SFWF) Outer Continental Shelf Permit

September 25, 2020

South Fork Wind (SFW) is providing the enclosed information in response to the United States Environmental Protection Agency (EPA) comments on the August 2020 Draft Air Qualty Modeling Protocol for Operations and Maintenance Emissions for the South Fork Wind Farm (SFWF) Outer Continental Shelf Air Permit.

Please see below specific agency comments in italic text followed by SFW responses in plain text:

1. *The protocol states that the "emergency generator [on the OSS] will only operate for emergencies and less than 200 hours per year of reliability testing, anticipated to be 30 minutes per month each." The Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (40 CFR 60 subpart IIII) allow emergency engines a maximum of 100 hours per calendar year for maintenance checks and readiness testing, including 50 hours per year of non-emergency use. See 40 CFR 60.4211(f)(2)&(3)(i). Under these rules, there is no time limit for running the engine during emergencies, and the source may petition EPA for additional hours to be used for maintenance checks and readiness testing, but a petition is not required if the owner or operator maintains records indicating that federal, state, or local standards require maintenance and testing of emergency engines beyond 100 hours per calendar year. Please adjust the text to clarify that whether and to what extent the 200 hours estimated includes allowed nonemergency versus emergency use.*

The report will be revised to state that the OSS emergency generator will operate a total of 100 hours per year for emergency and readiness testing. However, it is anticipated that during some maintenance activities, there will be a generator transported from onshore that will be used to power some equipment to conduct the repairs. This generator is anticipated to be used 200 hours per year at most and is likely the same size as the OSS generator (200 kw). The draft protocol states that the emissions associated with generator use will be included in the modeling Scenario 2 (Section 3.5) at 200 hours per year, which conservatively accounts for the impacts of the emergency OSS generator during testing. The emergency generator testing will not occur simultaneously with maintenance generator use.

2. *Please provide supporting information for the emissions rates and other emissions parameters for vessels proposed for use in the modeling analysis. Please include information about how the emissions rates were derived and why they are deemed appropriate as inputs to the modeling analysis, i.e., are they based on actual emissions reports versus standard emissions factors, and do they represent the highest emitting devices proposed for inclusion in the air permit.*

Background information regarding emission calculations for various operations and maintenance (OM) activities are provided in Attachment 1 of this supplementary memo. The emissions were derived using default BOEM emission factors as shown in Table 9 of Attachment 1.

The exact size and nature of the vessels and equipment to be used could vary based on availability and the specific nature of the work required. However, the emissions and modeling are based on the number of vessels and size of engines as listed above and in Table 10 Section 3.5 of the Modeling Protocol. The vessels and associated engine horsepower estimates were based on input from South Fork Wind LLC (SFW) and were based on other projects with similar work scope. A scenario that includes all of the equipment listed in Table 10 of Section 3.5 of the Protocol would provide appropriate estimates of total engine horsepower-hours and fuel usage that would actually be used and therefore will lead to conservative estimates of Project impacts. For example, it is unlikely that two feeder barges will be necessary for a large-scale repair project, but both were included in the proposed model scenario 2 to provide that flexibility to SFW.

3. *In the analysis of Class I air quality related values described in section 2.9.1, in addition to consulting with the Forest Service for Lye Brook Wilderness, please also apply the described Q/D analysis to the Brigantine Wilderness area and conduct appropriate consultation with the US Fish & Wildlife Service. In the Q/D analysis, the emissions (Q) should represent the annual emissions based on 24-hour maximum allowable emissions, rather than the annual potential to emit to be included in the permit.*

Correspondence has been sent to both USFS (Lye Brook) and the FWS (Brigantine) on September 18, 2020, which describes the project, and lists the annualized worst-case 24-hour emissions, along with the Q/D screening value for those emissions. No formal responses have been received from the FLMs as of September 30, 2020. Relevant correspondence will be included in the Air Quality modeling report for OM emissions.

4. *Section 2.9 of the protocol should be modified to include an analysis for PSD increment for Class I areas. EPA recommends using the results of OCD modeling at a nominal 50-km distance to screen for impacts at the nearest Class I area (Lye Brook Wilderness, 260+ km).*

The report will include an assessment of Class I impacts due to worst-case OM emissions and impacts. This assessment will be conducted by comparing the OCD model-predicted impacts at the 50 km receptors with the Class I PSD significant impacts levels.

5. *EPA requests that additional information be provided in Section 2.8 about under what circumstances the cumulative analysis will be performed and how decisions will be made about which potentially interactive sources would be included in such an analysis if it is necessary. EPA notes that any nearby source with a significant concentration gradient within the South Fork Wind Farm's significant impact area, or which consumes available PSD increment in the area, should be included in such an analysis. In particular, EPA suggests that Deepwater Wind assess whether the permitted air impacts and PSD increment consumption for the Vineyard Wind project should be included.*

According to 40 CFR Appendix W to Part 51, additional cumulative sources may have to be considered in a cumulative impact assessment if emissions from those sources create a "significant concentration gradient" in the vicinity of the modeled source (EPA, 2011 and 2017). A concentration gradient is the rate of change of concentration with distance, in both the longitudinal and lateral gradients. Significant concentration gradients in the vicinity of the source implies that the nearby source's potential interaction with the proposed source's impacts will not be well represented by the monitored concentrations at a specific location (for a NAAQS assessment). Concentration gradients are generally largest between the source and the location of the maximum ground-level impacts. This guidance suggests focusing on nearby sources within 10 kilometers of a proposed source in most cases.

A review was conducted of on-land sources with operating permits within 50 kilometers of a central point within the SFWF WDA. This review included both Massachusetts and Rhode Island sources. There were no sources with valid and current operating permits identified within 50 km of the WDA. These finding were confirmed by both Rhode Island DEM and Massachusetts DEP via email. Therefore, no additional on-land cumulative sources are proposed to be included in the NAAQS assessment as there are no sources that could have a significant concentration gradient in proximity to the Project sources. Similarly, since no major sources exist on-land within 50 km of the WDA, no on-land sources were included in the PSD cumulative assessment as there are no sources that would consume significant amounts of increment in the vicinity of the WDA.

Vineyard Wind (VW) has submitted an OCS permit application to EPA in 2019 for a wind development project southeast of the SFWF WDA. The center of VW WDA is more than 50 km from the approximate center of the SFWF WDA. The maximum significant impact radius for the Vineyard Wind was shown to be 1.5 kilometers or less (Vineyard Wind, 2019) for the modeled contaminants for 24-hour average impacts and all receptors were less than the applicable SIL for annual averages. Preliminary modeling shows that SFWF Project's significant impact radius is 4.5 kilometers or less for all short-term average impacts and zero for all annual-average impacts. Therefore, VW O&M emissions were not included in SFWF's NAAQS or PSD cumulative assessments. Should final modeling shows overlap of VW and SFWF significant impact areas, SFW will discuss with EPA an appropriate course of action.

Any other minor sources contributing to overall contaminant concentrations are included in the representative background air quality monitoring data being proposed for the NAAQS analysis, as discussed in Section 3.1 of the modeling protocol. Further, these overland background concentrations are likely conservative estimates of contaminant concentrations overwater in the vicinity of the SFWF WDA, which is far removed from various residential and most transportation emissions.

6. *Please clarify under what conditions the "turbine repair requiring jack-up barges" scenario would exist, and whether those conditions would increase the likelihood that multiple repairs would occur at nearby offshore wind farms as well. EPA encourages you to include nearby facilities for the annual standards to the extent that significant impact areas would overlap (see comment #4 above).*

The large-scale turbine (or OSS) repairs may occur as a result of unusual wear and premature failure of key electrical, structural, or mechanical components of the turbine equipment. These large-scale repairs are only anticipated perhaps 5-10 times over the life of the Project (25 to 30 years), and not every repair will require a jackup barge. If a severe weather event were to cause damage to several turbines at both the SFWF and Vineyard Wind (VW) sites, the repair schedule would be based on a number of logistical factors, including weather, vessel and work crew availability etc., and the likelihood of simultaneous repair scenarios is still small.

VW reported in their supplementary information memorandum (Vineyard Wind, 2019) that their modeled significant impact radii were 1.0 km for 1-hour NO_2, 0.5 km for 24-hour PM_{10} and 1.5 km for 24-hour $PM_{2.5}$ (Table 5-1 of the VW memo). Vineyard Wind also reported that there were no receptors above the SIL for any annual averaging periods. Preliminary modeling of the SFWF also shows that there are no modeled contaminants with impacts above the SIL for annual averages. Therefore, based on these preliminary results, it is not deemed necessary to include VW emission impacts as cumulative sources to SFWF model predicted annual averages. Should the final SFWF model results show a significant increase in predicted annual average results resulting in overlap of the VW work area, EPA will be consulted, and an appropriate course of action discussed.

7. Please provide additional detail for the Soils, Vegetation, and Growth analyses described in sections 3.10 and 3.11 of the protocol.

A component of the PSD documentation requires an analysis of potential air quality impacts on sensitive vegetation types that may be present near the Project. The evaluation of potential impacts on vegetation will be conducted in accordance with EPA's *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA 1980). Model predicted air quality concentrations of various pollutants from the Project will added to ambient background concentrations and compared to applicable screening concentrations to determine whether there exists the potential for adversely impacting vegetation with significant commercial or recreational value. The worst-case project impacts are entirely over water with the nearest land being Block Island approximately 19 miles east northeast of the WDA and therefore this comparison is conservative.

For growth, a qualitative assessment will be provided that summarizes project-related activities and infrastructure that could potentially result in direct or indirect impacts to population, economy, and employment resources. A summary of a socioeconomic analysis performed by Navigant Consulting Inc and provided in the SFW Construction and Operations Plan (SFW, 2020) will be provided in the modeling report. That analysis assessed impact-producing factor such as the socioeconomic factors population, economy, and employment, coastal land uses, and tourism. A statement of the potential impacts of secondary growth on air emissions will be provided.

8. The Guideline on Air Quality Models (40 CFR part 51, Appendix W; the Guideline) specifies that building downwash shall be included in modeling assessments of stationary sources (see sections 4.2.2 and 7.2.2). Please list any structures that will be included in the downwash analysis and provide their dimensions and schematic information.

Structure downwash will be incorporated into the OCD model by specifying a structure height and width that are nearby a specific source and could influence dispersion from that source. The building downwash due to platform influence is treated in OCD using a revised platform downwash algorithm based on laboratory experiments, where dispersion coefficients are enhanced, and final plume rise is reduced as a result of downwash effects (DiCristofaro and Hanna, 1989). The main structure for scenarios that could influence dispersion is the OSS structure. The final design of the OSS structure has not yet been determined but based on information provided by SFW in the COP (SFW, 2020), the height of the OSS structure above water level can be 45.7 to 61 m high, a typical value of 50 m height was assumed. This structure will sit on a single monopile foundation once it is erected. The maximum lateral distance is estimated at approximately 50 meters. The structure dimensions and associated downwash are conservative in that it assumes a solid foundation down to sea level, instead of the OSS being several meters above sea level on the monopile foundation.

These downwash dimensions will be assigned to the jackup barge and the feeder barges as these vessels will be likely attached or near the OSS structure during large scale repairs and therefore be potentially influenced by its wake effects. The power generator may be located on top of the OSS platform and therefore may be subject to its influence as well. The CTVs are assumed to be moving and away from the platform such that its emissions release is mostly independent of the platform wake, and therefore downwash effects were not assigned to these vessels.

The solid structures on the vessels (superstructure, vessel hulls) themselves are considerably smaller than those of the OSS and therefore downwash from these on-vessel structures are anticipated to be minor compared to the influence of the OSS. Also, the exact dimensions of the various vessels to be used will likely change each visit, and therefore modeling a single vessel "layout" for downwash purposes is not appropriate.

References

DiCristofaro, D., and S.R. Hanna 1989. "OCR: The Offshore and Coastal Dispersion Model, Volume I: User's Guide". Prepared for the U.S. Department of the Interior, Minerals Management Service. November 1989

South Fork Wind LLC (SFW), LLC. 2020 *South Fork Wind Farm Construction and Operations Plan. Revision 3.* Submitted to the Bureau of Ocean Energy Management. February.

EPA. 2011. "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard". March 1.

EPA. 2017. Appendix W to 40 CFR 51. *Guideline on Air Quality Models*. January.

Vineyard Wind, LLC. 2019. Memorandum to Leiran Biton, US EPA Region 1. Subject: Vineyard Wind Project, Supplemental Information Request by EPA Region 1, Construction and O&M Stage Modeling, from J. Sabato, and AJ Jablonowski, Epsilon Associates, Inc., April 22.

Attachment 1 - Background Information on Emission Estimates

Tables in this attachment summarize the source parameters and emissions.

Table 1. Source Parameters and Emissions during Operations and Maintenance Repair Scenario

Vessel	Count	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
Jack-up Vessel	1	20	1.0	3.3	555
CTVs 1 and 2	2	10	0.33	20	555
Feeder Barge, Main Repair Vessel, and Liftboat	2	30	0.6	6.6	800
268-bhp (200-kW) Generator	1	53[a]	0.33	39.38	758
New Bedford, ProvPort, New London Lines[b]	[c]	10	2	5.5	350
Shinnecock Transit Line[d]	[c]	10	0.33	20	555

[a] Assume located on top of OSS or WTG deck (approximate).

[b] Same parameters as construction line sources assumed.

[c] Point source every 0.6-3.1 miles (1-5 km) of line distance.

[d] Parameters same as CTV

Notes:

bhp = break horsepower

CTV = crew transport vehicle

K = Kelvin

km = kilometer(s)

kW = kilowatt(s)

m = meter(s)

m/s = meter(s) per second

OSS = offshore substation

ProvPort = Port of Providence, Rhode Island

WTG = wind turbine generator

Table 2. Short-term Emissions during Operations and Maintenance

Vessel	Scenario 1 Count	Scenario 2 Count	Annual Hours of Use[d]	NO_x (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Jack-up or Survey Vessel	0	1	112	0.0221[a]	0.048[b]	0.046[b]
Daily O&M CTV	1	0	2002	0.472[a]	0.0042[b]	0.0040[b]
CTV	1	1	168	0.0099[a]	0.008[b]	0.0077[b]
Feeder Barge, Main Repair Vessel, Liftboat [a,b,c]	0	2	112	0.0677[a]	0.169[b]	0.158[b]
268-bhp (200-kW) Generator [a,b]	0	1	200	0.0076[a]	0.0061[b]	0.0061[b]
Shinnecock Transit (Entire Line)	Not modeled for short-term average	Not modeled for short-term average	NA	NA	NA	NA
New London, ProvPort, New Bedford Transit (Entire Line)	Not modeled for short-term average	Not modeled for short-term average	NA	NA	NA	NA

[a] 1-hour emissions.

[b] 24-hour emissions.

[c] Emissions shown per vessel or generator.

[d] Anticipated number of hours of use onsite (not including transit time) applied to 1-hour NOx emissions

Notes:

g/s = gram(s) per second

NA = not applicable

NOx = nitrogen oxide

O&M = operations and maintenance

$PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

PM_{10} = particulate matter less than 10 micrometers in aerodynamic diameter

Table 3. Annual Emissions during Operations and Maintenance Repair Scenario

Vessel	Count	NO_x (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Jack-up or Survey Vessel	1	0.0179	0.0005	0.0005
Daily O&M CTV	1	0.108	0.0036	0.0035
CTV	1	0.0070	0.0002	0.0002
Feeder Barge, Main Repair Vessel, Liftboat[a]	2	0.115	0.0037	0.0034
268-bhp (200-kW) Generator	1	0.0076	0.00014	0.00014
Shinnecock Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.411	0.0138	0.0134
New London Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.215	0.0067	0.0064
New Bedford Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.123	0.0038	0.0036
ProvPort Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.127	0.0039	0.0038

[a] Emissions shown per vessel or generator.

[b] Total line source emissions.

Table 4. South Fork Wind Farm Operations and Maintenance Annual Emission Summary

Areas Where Emissions Occur	NO_x	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area - New Bedford	**27.4**	**0.9**	**0.9**
Transit emissions	18.6	0.6	0.6
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0
Total Emissions within OCS Area - ProvPort	**27.6**	**0.9**	**0.9**
Transit emissions	18.7	0.6	0.6
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0
Total Emissions within OCS Area – New London	**30.6**	**1.0**	**1.0**
Transit emissions	21.8	0.7	0.7
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0

[a] All vessels in total.

Notes:

Units in tpy.

OCS = Outer Continental Shelf

tpy = ton(s) per year

Table 5. South Fork Wind Farm Operations and Maintenance 24-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area - New Bedford	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Shinnecock)[a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006
Emissions within OCS Area - ProvPort	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Shinnecock) [a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006
Emissions within OCS Area – New London	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Shinnecock) [a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006

[a] Not modeled for 24-hour averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in tons per 24 hours.

Table 6. South Fork Wind Farm Operations and Maintenance 24-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area – New Bedford	**13.48**	**0.42**	**0.40**
Transit emissions (Shinnecock) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01
Total Emissions within OCS Area - ProvPort	**13.48**	**0.42**	**0.40**
Transit emissions (Shinnecock) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01
Total Emissions within OCS Area – New London	**13.48**	**0.42**	**0.40**
Transit emissions (Shinnecock) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in g/s.

Table 7. South Fork Wind Farm Operations and Maintenance 1-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Emissions within OCS Area New Bedford	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000
Emissions within OCS Area - ProvPort	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000
Emissions within OCS Area – New London	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in tons per hour.

Table 8. South Fork Wind Farm Operations and Maintenance 1-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Emissions within OCS Area – New Bedford	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006
Emissions within OCS Area – ProvPort	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006
Emissions within OCS Area – New London	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in g/s.

Table 9. Transit and Maneuvering Emission Factors

Engine	Type	Units	Emission Factors									
			CO_2	CH_4	N_2O	Black Carbon	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Main	Anchor Handling Tugs	g/kW/h	6.36E+02	4.00E-03	3.10E-02	2.54E-01	2.16E+00	9.26E+00	3.44E-01	3.30E-01	7.87E-02	4.03E-05	2.39E-01
Main	Barge	g/kW/h	5.89E+02	4.00E-03	3.10E-02	3.23E-01	1.40E+00	1.36E+01	4.50E-01	4.20E-01	3.62E-01	1.18E-05	6.30E-01
Main	Crew	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.31E-01	2.30E+00	9.15E+00	3.10E-01	3.00E-01	6.24E-03	4.65E-05	1.37E-01
Main	Jack-up	g/kW/h	6.47E+02	4.00E-03	3.10E-02	2.29E-01	2.30E+00	1.00E+01	3.08E-01	2.98E-01	1.27E-02	4.51E-05	1.44E-01
Main	Research and Survey	g/kW/h	6.38E+02	4.00E-03	3.10E-02	2.51E-01	2.25E+00	9.86E+00	3.39E-01	3.26E-01	6.57E-02	4.15E-05	2.21E-01
Main	Tug	g/kW/h	6.44E+02	4.00E-03	3.10E-02	2.43E-01	2.29E+00	9.52E+00	3.27E-01	3.16E-01	3.33E-02	4.48E-05	1.77E-01
Main	Cable Laying	g/kW/h	6.35E+02	4.00E-03	3.10E-02	2.52E-01	2.20E+00	9.49E+00	3.41E-01	3.27E-01	8.51E-02	3.88E-05	2.46E-01
Main	Dredging	g/kW/h	6.31E+02	4.00E-03	3.10E-02	2.63E-01	2.13E+00	9.60E+00	3.57E-01	3.41E-01	1.12E-01	3.70E-05	2.85E-01
Main	Shuttle Tanker	g/kW/h	5.89E+02	4.00E-03	3.10E-02	3.23E-01	1.40E+00	9.05E+00	4.50E-01	4.20E-01	3.62E-01	1.18E-05	6.30E-01
Main	Supply Ship	g/kW/h	6.45E+02	4.00E-03	3.10E-02	2.38E-01	2.29E+00	9.44E+00	3.20E-01	3.09E-01	2.77E-02	4.45E-05	1.67E-01
Main	Ice Breaker	g/kW/h	6.11E+02	4.00E-03	3.10E-02	2.90E-01	1.78E+00	9.92E+00	3.99E-01	3.77E-01	2.30E-01	2.48E-05	4.48E-01
Auxiliary	Anchor Handling Tugs	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.88E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Barge	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.26E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Crew	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.04E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Jack-up	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.15E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Research and Survey	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.02E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Tug	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.01E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Cable Laying	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.89E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Dredging	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.85E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Shuttle Tanker	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.80E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Supply Ship	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.04E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01

Table 9. Transit and Maneuvering Emission Factors

Engine	Type	Units	Emission Factors										
			CO_2	CH_4	N_2O	Black Carbon	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Auxiliary	Ice Breaker	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	2.48E+00	1.01E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01

Engine Loading Factor:	**BOEM Tool default loading factors are used.**	**Propulsion Engine**	**Auxiliary Engine**	**Maneuvering**
		0.82	1	0.2
Vessel Emissions (tons) =	***Engine Power Rating (kW) x Loading Factor x Activity Hours (hours) x Emission Factor (g/kW/h) x (1 lb / 454 g) x (1 ton / 2,000 lb) x (No. of Sources)***			

Notes:

BOEM = Bureau of Ocean Energy Management

CH_4 = methane

CO = carbon monoxide

CO_2 = carbon dioxide

g = gram(s)

g/kW/h = gram(s) per kilowatt per hour

kW = kilowatt(s)

lb = pound(s)

N_2O = nitrous oxide

No. = number

NOx = nitrogen oxides

$PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

PM_{10} = particulate matter less than 10 micrometers in aerodynamic diameter

SO_2 = sulfur dioxide

VOC = volatile organic compound

Table 10. Annual Emission Estimate for Transit in Offshore and Coastal Dispersion Model Area

Type of Equipment and Emission Source Description (list others as needed)	Vessel Type in BOEM Tool for Emission Factor Selection	No. of Each Type of Vessel	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours for Transit Within OCS Area	NO_x	PM_{10}	$PM_{2.5}$
Shinnecock, New York						**14.29**	**0.48**	**0.47**
CTV	Crew	1	881	43	1,837.7	14.29	0.48	0.47
Port of New Bedford, Massachusetts based						**4.27**	**0.13**	**0.13**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	13.6	2.15	0.06	0.06
CTV	Crew	1	881	43	24.6	0.19	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	10.9	1.93	0.06	0.06
ProvPort, Rhode Island based						**4.43**	**0.14**	**0.13**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	14.1	2.23	0.07	0.06
CTV	Crew	1	881	43	25.4	0.20	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	11.3	2.00	0.06	0.06
Port of New London, Connecticut based						**7.47**	**0.23**	**0.22**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	23.7	3.76	0.11	0.11
CTV	Crew	1	881	43	42.9	0.33	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1119	19.0	3.38	0.11	0.10

Notes:

Units are tpy.

Transit emissions assume load factor of 0.82 for all main engines, and 1 for auxiliary engines.

Table 11. South Fork Wind Farm Onsite Emergency Generator

Type	Units	Emission Factors									
		CO_2	CH_4	N_2O	Black Carbon	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Offshore emergency generator	g/kW/h	6.5E+02	4.0E-03	3.1E-02	8.5E-02	2.0E+00	6.0E+00	1.1E-01	1.1E-01	6.0E-03	7.0E-02
Emission calculation: *Generator Emissions (tpy) =*	*Engine Power Rating (kW) x Activity Hours (hours/year) x Emission Factor (g/kW/h) x (1 lb /454 g) x (1 ton / 2000 lb) x (No. of Sources)*										

Type of Equipment and Emission Source Description (list others as needed)	No. of equipment	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours - annual testing and run time	NO_x	PM_{10}	$PM_{2.5}$
Generator (268 bhp [200 kW])	1	200		200.0	0.263	0.005	0.005

Notes:

Units are tpy.

Table 12. Annual Emission Estimate for Onsite Maneuvering

Type of Equipment and Emission Source Description (list others as needed)	Vessel Type in BOEM Tool for Emission Factor Selection	No. of Each Type of Vessel	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours - Maneuvering Onsite	NO_x	PM_{10}	$PM_{2.5}$
Shinnecock, New York						**3.75**	**0.13**	**0.12**
CTV	Crew	1	881	43	2002.3	3.75	0.13	0.12
Port of New Bedford, Massachusetts based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12
PortProv, Rhode Island based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12
Port of New London, Connecticut based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12

Notes:

For onsite maneuvering, CTVs and feeder barges assume load factor of 0.2 for both main and auxiliary engines; jack-up barge assumes load factor of 0.2 for the auxiliary engine only.

Emission units are tpy.

Attachment 2 - Figure of Typical OSS Structure